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On the Distances of the Cepheids

In *Bulletin of the Astronomical Institutes of the Netherlands* No. 8, Kapteyn and van Rhijn published a list of proper motions for 17 Cepheids, from which they derived a mean secular parallax of 0″.0029 (for m = 5.32), agreeing well with Shapley's[1] value of 0″.0034 (for m=5.0). This parallax rests, however, on the assumptions that the Sun's velocity is 19.5 km/sec[2], and that the Cepheids as a group are at rest with reference to the stellar system. Evidence for the truth of this last assumption is afforded by the fact that an apex determination by the writer from the radial velocities of 12 of these stars yields the values: A = 242°, D = + 28°, V = 21.6 km/sec. This same assumption was made by Hertzsprung[3] and Shapley in deriving their mean parallax; furthermore Shapley proved that the radial velocities of 20 Cepheids after correcting for a solar velocity of 21.5 km/sec, show no preferential motion at all. For he finds for the apex of such a hypothetical drift: A = 275° ∓ 195°, D = + 74° ∓ 131°, V = 6.4 ∓ 3.0 km/sec.

It may therefore be expected that the proper motions give a solar apex determination in fair agreement with the one found above from radial velocities, and a solution was accordingly made for the 17 Cepheids of Kapteyn and van Rhijn. In this solution it was assumed that Shapley's[4] parallaxes were correct, relative to each other, and by means of these, the proper motions were reduced to the same distance. The result is A = 290° ∓ 140°, D = — 33° ∓ 188°, V = 25 ∓ 54 km/sec[5], i. e., close to the place where the Cepheids are most crowded. The value for the velocity is of course entirely dependent upon the parallaxes, and should be multiplied by r if the parallexes proved to be r times too large.

As the errors in Shapley's parallaxes are distributed logarithmically, a solution was also made, using the logarithm of the proper motion. The apex thus found is: A=279°, D=+10°, V=14 km/sec. The first solution is largely dominated by the one single star Y *Ophiuchi*, but as the proper motion of this star is of no less accuracy than the others (probable error less than one-fifth of the total μ, whereas for S *Sagittæ* probable error = μ) there was no reason for exclusion.

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[1] *Mt. Wilson Contributions*, **151**, 1918.

[2] A value of 21.5 km/sec. for the solar motion would change Kapteyn and van Rhijn's parallax to 0″.0026.

[3] *A. N*,, **196**, 203, 1913.

[4] *Mt. Wilson Contributions*, **153**, 1918.

[5] The errors were derived according to the rules for the computation of the mean error, but can hardly be called so.

As the results of the radial velocities[6] leave little doubt as to the fact that the apparent motions of the Cepheids are in the mean an effect of the solar motion, the uncertainty in apex determination from proper motions warns us not to place too much faith in a mean parallax derived from parallactic motions. It seems therefore the safest policy for the immediate future, to adopt the conclusion arrived at by Curtis[7] and Kapteyn and van Rhijn, viz., to suspend judgment on all the important deductions involving the knowledge of the parallax of clusters until our data are more reliable.

In so far as the distances of the Cepheids bear on the general problem of galactic dimensions, it may be noted here that another indication of the desirability of reducing Shapley's distances is given by the parallax for M11 as derived by Lindblad[8]. His adopted value of $M - m = -12$ for this cluster (derived from the magnitudes of the A- and K-giants) corresponds to $\pi = 0''.00040$ (instead of $0''.00025$ as published by him) thus making it almost three times as close as Shapley[9] ($0''.00014$).

This may be supplemented by my estimate for the parallax of M52 derived from photographic magnitudes of 400 stars, determined at the Royal Observatory, Greenwich. The mean magnitude of the ten brightest stars (omitting the very brightest, which is still two magnitudes brighter and may not belong to the cluster) is $11^m.3$. Assuming these to be A-stars with an absolute magnitude as high as $0^m.0$ (for the highly luminous B-giants are rare in open clusters) we obtain $M - m = -11.3$ and accordingly as a lower limit for the parallax $0''.00055$, whereas Shapley (l. c.) finds $0''.00016$ from estimates of diameter.

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1922, April 17.

STARS WHOSE RADIAL VELOCITIES VARY

In the progress of our spectrographic observations of the naked-eye stars, to determine their velocities of approach and recession, cases of variable velocity have been noted as in the table below. The highest and lowest observed velocities for each star whose recorded spectrum shows but a single series of lines are set down in the next to the last column. Two series of lines

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[6] The distribution over the sky is unfavourable in both cases.

[7] *Bulletins National Research Council*, **2**, 203, 1921.

[8] *Astroph. Journ.*, **55**, 85, 1922.

[9] *Proc. Nat. Acad. of Sciences*, **5**, 344, 1919.